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Chemical Enhanced Oil Recovery (EOR) Activities in Indonesia: How it's Future

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Abstract. Enhanced oil recovery (EOR) is a proven method for increasing oil production in many oil fields in the world. Huge oil remaining in the reservoir after primary and secondary recovery stage are the main reason for developing EOR methods. Approximately of 49.50 billion barrels oil as a candidate for EOR activities in Indonesia. This present study focuses on the chemical EOR activities involved surfactant and polymer. This research based on pertinent information from various resources such as journal papers, conference papers, and report from the government. Based on this information, this paper explain in detail the progress of each project and it shows the potential oil field employ chemical EOR in the near future. Generally, the EOR activities can be categorized into two phases such as preliminary study phase and field implementation phase. In the preliminary study, the activities simply involve experimental and/or simulation works. Following the preliminary is the field implementation phase which can be categorized into three phases such as field trial, pilot project, and full-scale. In fact, several activities have been conducted by Lemigas (government oil and gas research center), Institut Teknologi Bandung, Institut Pertanian Bogor. These activities focused on laboratory and simulation work. Those institutions have been developing the chemical formula collaborating with oil companies for applying the EOR method in their oil fields. Currently, status of chemical EOR activities include 5 oil fields under pilot project and 12 oil fields under field trial. There are 7 oil fields applying surfactant, 4 oil fields by alkaline-surfactant-polymer (ASP), 2 oil fields by polymer, 1 oil field by surfactant polymer (SP), and 1 oil field by caustic. According to this information, we will have insight knowledge about the EOR current activities, the main issues, future activities on chemical EOR in Indonesia. Moreover, this study can became the preliminary information for researchers who interested conducting further research and development on the chemical EOR activities in the near future.

Key words: EOR, polymer, surfactant, oil fields.

INTRODUCTION

Indonesia is a large country with total population more than 250 million. In order to supply energy demand for daily activities, the government have been provided ± 1.6 million barrels per day since 2015. However, oil production has been decreasing since 1996 with daily oil production of 776,000 BOPD in 2015 (Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia, 2015). The peak of oil production reached 1.6 million barrels per day in 1977 and 1995. Several major factors caused by the oil production decline in particular: mature oil fields, have yet discovered a giant fields like Minas and Duri, and oil production stage under primary and secondary recovery (Aprilian et al., 2003).

Numerous effort has been made for improving oil production such as infill drilling, water injection, well stimulation, and workover. According to the Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia in 2012, the remaining oil can produce uses enhanced oil recovery (EOR) methods are approximately 4 billion barrels. The enhanced oil recovery method has been implemented in Duri Field since 1975

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(Pearce and Megginson, 1991; Sutadiwira and Azwar, 2011). A billion barrel oil has been produced from that field using steamflooding method. Unfortunately, this method only favorable for high oil viscosity and shallow depth reservoir such as Duri Field. Low oil viscosity and deep reservoir are the major feature of oil fields in Indonesia. Based on these oil fields characteristic, the steamflooding cannot be implemented in other fields. Chemical EOR is the other methods applying surfactant, polymer, surfactant-polymer (SP), and alkaline surfactant polymer (ASP). They are more convenient for this low oil viscosity type. In addition, the other ways are through the solvent method such as CO_2 injection, hydrocarbon gas injection, etc. (Lake, 1989).

This study presents the chemical EOR method for improving oil recovery. As well as briefly and exhibits the recent chemical activities enhanced oil recovery and the main issues. Furthermore, prediction of chemical EOR activities in the near future for improving oil recovery in Indonesia. All the data were collected from various sources such as journal paper, conference paper, and report from government for supporting this research. According to this study, this paper would be produced valuable information for researchers who have interest with this topic. Afterward, they may propose a further study to develop chemical formula for improving oil recovery under the laboratory work.

OIL PRODUCTION PROFILE

Oil production has been declining after the second peak since 1995. The decline rate between 10 % and 12% from 1996 to 2003. Due to some effort such as infill drilling, well stimulation, and new oil field start to production, the decline rate turn out 3-5% since 2004 up to now. The average oil production of 802,000 BOPD in 2015 (Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia, 2015). Figure 1 shows the oil production history, current and forecasting in Indonesia since 1966.

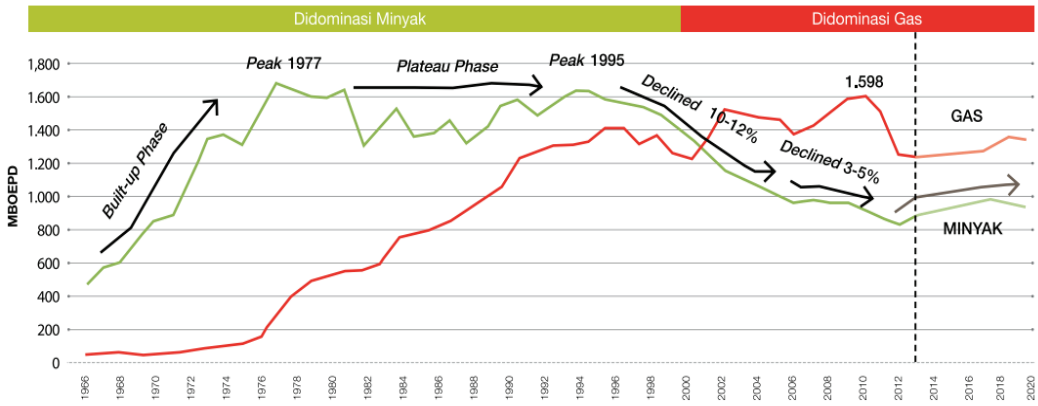

FIGURE 1. Oil production past, present and future (Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia, 2015).

Currently, the most activities of oil production stage are under primary and secondary recovery. These stages have been implemented in almost of oil field in Indonesia. In the primary recovery, the oil produce only by using pump without make use of external energy to push the oil out from the reservoir. Meanwhile in the secondary recovery, oil companies inject some amount of water to increase or maintain the pressure in the reservoir which has been depleted during the production time. In addition, this method also uses the water to push oil flowing into the well. Figure 2 shows the production stage involves primary, secondary, and tertiary recovery in Indonesia. Based on this figure, almost of oil fields are under primary and secondary recovery stages. However, one of enhanced oil recovery method has been implemented in Central Sumatra Basin and until now it is the only one area that applied enhanced oil recovery in Indonesia.

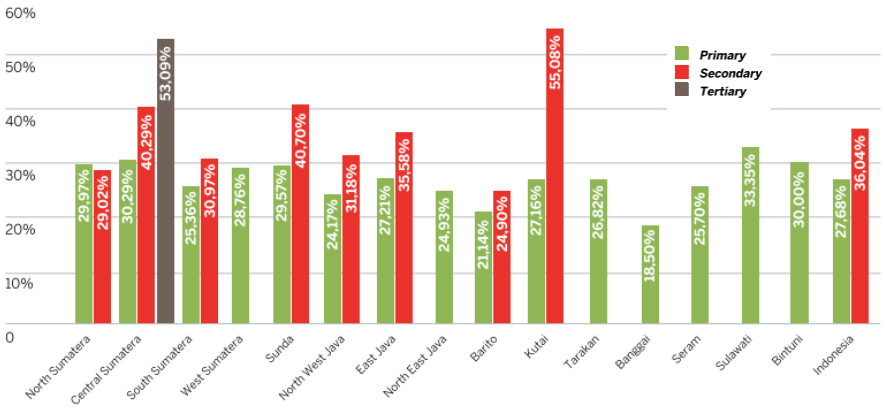

FIGURE 2. Oil production past, present and future (Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia, 2014).

CHEMICAL EOR ACTIVITIES

Chemical EOR, the main goals is to recover more oil by either one or a combination processes such as: mobility control by adding polymers to reduce the injected fluid, reducing of interfacial tension by using surfactants, or alkaline. Chemical enhanced oil recovery is proven method for improving recovery from several oil fields in the world. The successful oil fields which have been injected using chemical EOR included Daqing Field in China and Pelican Lake in Canada (Kottungal, 2014). In fact, chemical activities for improving oil recovery can be divided into two stages. The first stage, the activities conducted either in laboratory and/or simulation study. Second stage involved field trials, pilot project, and full scale implementation. In any case, the progress chemical activities involving laboratory work, simulation and field trial or pilot project has been conducted in the oil fields (Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia, 2012, 2013, 2014, 2015). Figure 3a and 3b shows the chemical EOR activities as field trial in the oil field. Several laboratory studies and field trial have conducted under chemical EOR activities such as in Minas, Tanjung, Kaji Semoga, etc. Table 1 shows the chemical EOR activities involved laboratory study, field trial and pilot project.

FIGURE 3a. Surface facility for chemical storage (Zulfikar et al., 2014).

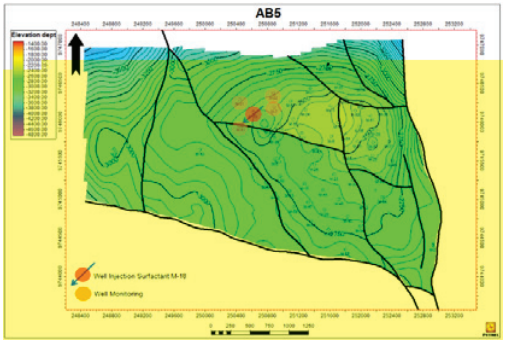

FIGURE 3b. Injector and monitor well for chemical EOR activities (Zulfikar et al., 2014).

TABEL 1. Chemical Activities in Indonesia

No	Fields Name	Status	EOR Type	Year	Province
1	Widuri	Pilot Project	Polymer	2015	North Jakarta (Off Shore)
2	Limau	Pilot Project	ASP	2015	South Sumatra
3	Minas	Field Trial	Polymer	2015	Riau
4	Kaji Semoga	Pilot Project	Surfactant Polymer	2014	South Sumatra
5	Tanjung	Pilot Project	Surfactant	2014	South Kalimantan
6	Minas	Pilot Project	Surfactant	2013	Riau
7	Kaji Semoga	Field Trial	Surfactant (Huff n Puff)	2013	South Sumatra
8	Tanjung	Field Trial	ASP	2013	South Kalimantan
9	Widuri	Field Trial	Surfactant	2013	North Jakarta (Off Shore)
10	Zamrud	Field Trial	Surfactant (Huff n Puff)	2013	Riau
11	Pedada	Field Trial	Surfactant (Huff n Puff)	2012	Riau
12	Meruap	Field Trial	Surfactant (Huff n Puff)	2012	Jambi
13	Kenali Asam	Field Trial	No Information	2012	Jambi
14	Ledok	Field Trial	No Information	2012	Central Java
15	Limau	Field Trial	ASP	2010	South Sumatra
16	Handil	Field Trial	ASP	1980	Eastern Kalimantan
17	Duri	Field Trial	Caustic	1975	Riau

BARRIER OF CHEMICAL EOR ACTIVITIES

Farouq Ali (1996) emphasized that the technology of EOR is so complex that it remains a costly operation, the amount of activity in EOR depends on oil price, royalty and tax advantages. The oil price has been falling down since late in the year 2014. The effect of oil price is significant. In current condition it will be disadvantageous to develop EOR projects in Indonesia. However, there are other barriers involved such as huge initial capital investments, high chemical cost due to the material is imported from overseas, lack of expertise, old facilities, and lack of data due to old oil fields. These barriers lead to slow down the chemical EOR activities in Indonesia. However, laboratory research and simulation work are still at the front of EOR activities in this condition (Paryo et al., 2006; Suryo and Murachman, 2001; Eni et al., 2007 and 2008; Kristanto and Bintaro, 2008).

PROSPECTS OF CHEMICAL EOR ACTIVITIES

Primary and secondary recovery production stages have been implemented in almost of every oil fields in Indonesia. However by using this method, it still leaving considerable amount of oil in the reservoir. According to Special Task Force for Upstream Oil and Gas Business Activities Republic of Indonesia annual report (2011), the remaining oil in the reservoir is approximately 49.50 billion barrels. Lake (1989), roughly estimates the additional oil recovery using of chemical EOR method between 5- 15% of the original oil in place. In this case, chemical EOR method is able to squeeze out at least 2.48 – 4.90 billion barrels oil as additional oil recovery. This is a huge amount of oil and it can be produced for many years.

FUTURE CHEMICAL EOR ACTIVITIES

Chemical activities are still progressing in recent years. Some universities and oil companies are collaborating in order to get proper chemical formulas for certain reservoir conditions. For example, Institut Pertanian Bogor, Universitas Gajah Mada, Institut Teknologi Bandung has been conducting further study for chemical EOR using local material such as based on palm fruit. These activities are very important in developing chemical EOR in the near future. Demand of chemical for EOR activities are very high, the total amount of chemical for current projects is approximately 8 million tons (Sumirat, 2014). Chemical EOR have stimulated researchers from universities for conducting laboratory study since several years ago. Figure 4 shows some of chemical EOR activities in the oil field since 1975. This figure shows that average chemical EOR activities have been raised from 2010 to 2015. However, a

number of chemical EOR activities slowdown between 2014 and 2015. Oil price is the main effect of implementing EOR activities. In fact, the oil price has fallen down since 2014. Afterward, low of oil price lead to decreases chemical EOR activity from 2014 to 2015.

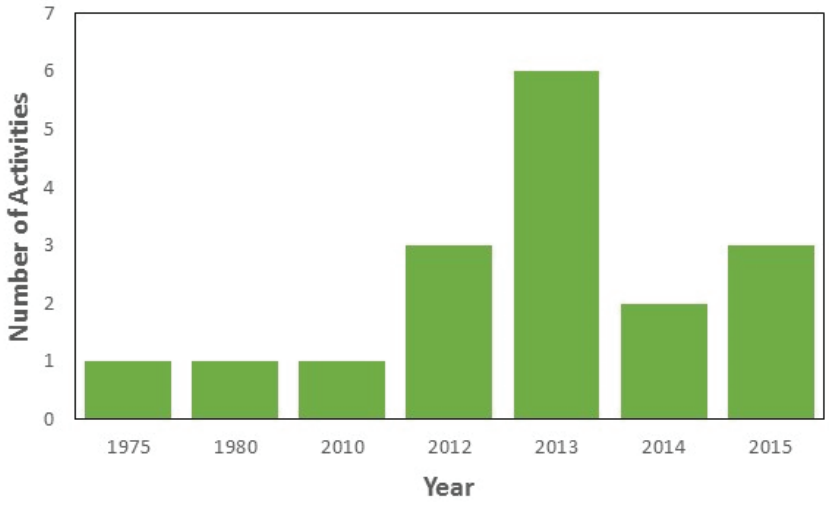

FIGURE 4. Number of chemical EOR activities for a year in 1975 to 2015.

CONCLUSIONS

Oil production has declined since 1996. In order to increase the oil production, several efforts have been done such as infill drilling, water injection, well stimulation, and work over. Due to the oil fields getting old, these activities cannot increase oil production significantly. The chemical EOR method has proved in some oil field which can prolong oil field life as well as increase the oil production from the mature field in the world. After primary and secondary production stage, amount of oil in the reservoir is approximately 49.50 billion barrels. Using chemical EOR methods such as surfactant, polymer, surfactant-polymer, alkaline-surfactant-polymer the additional oil can be produced from 2.49 to 4.95 billion barrels. However, these activities need more effort from laboratory studies to field implementation. Currently, the biggest problem for implementing chemical EOR is oil price. As we know, the low oil price delayed chemical EOR activity. However, laboratory studies are still existing and progressing to the right path finding the right chemical formula before applying that in the oil fields.

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